RIC 2002
W1
Circumferential Cracking of Reactor Vessel Head Penetration Nozzles

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Dominion Response to Bulletin

- Would perform 100% effective visual inspection for NAPS 1 and SPS 1 during fall RFO and 100% NDE on NAPS 1 (if equipment reliable)
- Evaluate results from NAPS 1 and SPS 1 to assess inspection timeframe for NAPS 2 and SPS 2
- Based on inspection results, decision was made to inspect all units by year end in accordance with bulletin recommendation
- Supplemental response to bulletin provided results of plant specific analysis for SPS and NAPS which qualified visual examination

North Anna Unit 1

- 100% qualified visual performed
  - Heavy boric acid deposits on 50% of head (active canopy seal weld leak found at shutdown)
  - Crawler unreliability in part due to debris on head
  - 34 of 65 penetrations with relevant boric acid deposits

North Anna Unit 1

- NDE campaign
  - Eddy Current (EC) plan based on visual results
  - Delivery system unreliable therefore could not obtain NDE data on 100% of penetrations
  - Access was limited due to “unique” centering rings
  - Ultrasonic Testing (UT) performed based on EC results
    - 6 of 8 tubes with EC recordable indications inspected with UT – very shallow axial indications, other 2 were conservatively sized based on 2:1 aspect ratio
    - Result showed EC conservatively sized indications
    - Tubes dispositioned by flaw evaluation

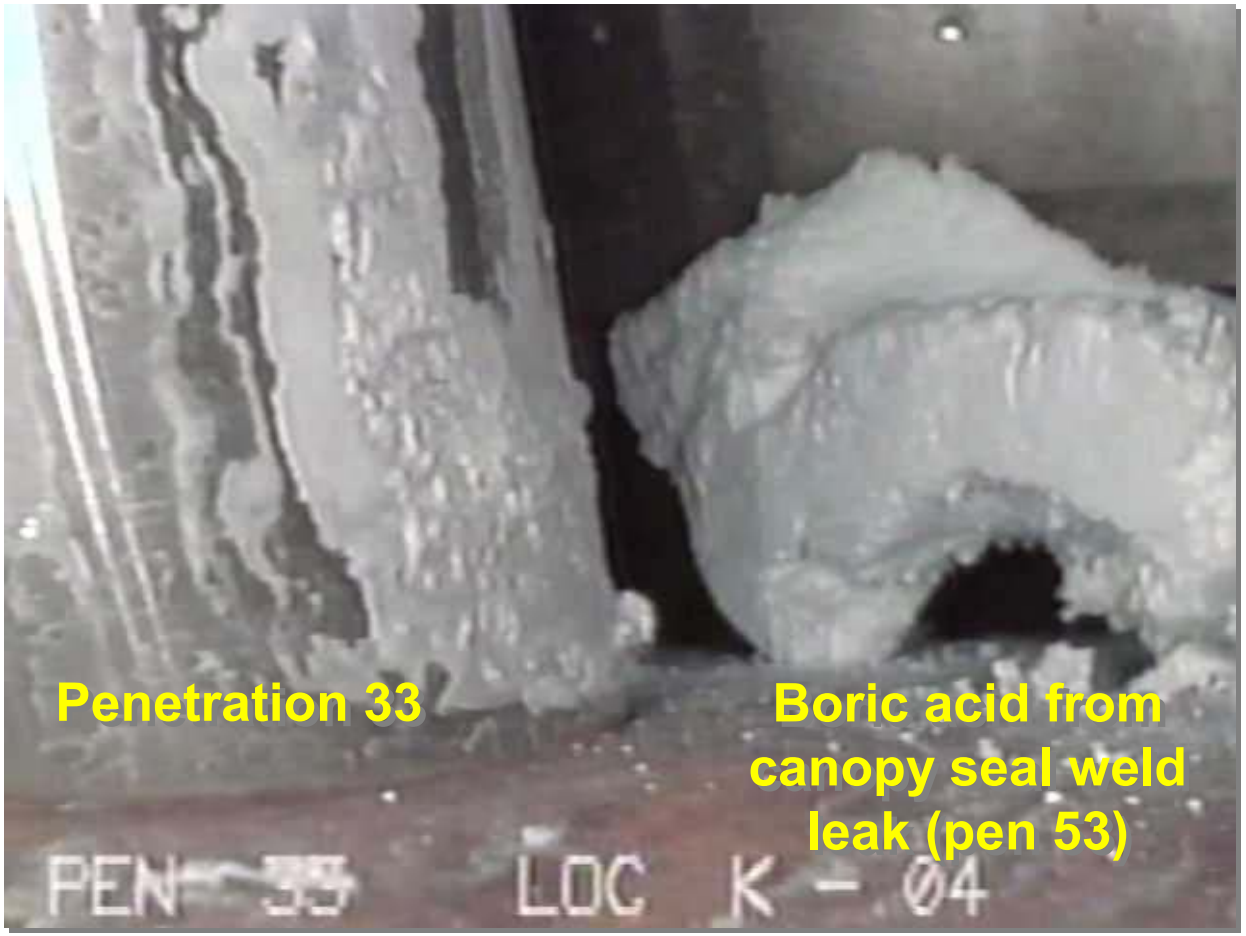
North Anna Unit 1

- NDE campaign (continued)
  - Liquid Penetrant (LP) utilized to disposition J-groove weld recordable indications
  - 3 of 5 penetrations examined with manual LP
  - 2 of 5 penetrations accepted by review of EC data compared to LP results
  - NDE Level III determined indications in clad material

North Anna Unit 1

- Penetration 50
  - Penetration not in boric acid field from canopy seal weld leak
  - EC of tube showed non-recordable indications in tube (98% coverage)
  - EC showed 4.3 mm indication in the clad (not recordable)
  - UT of tube ID – no recordable indications but limited to 97 degrees
  - LP of weld – indications in clad and crater crack in the weld (crater crack was ground out)
  - Removed thermal sleeve to obtain full access – full access UT revealed no recordable indications including a circumferential UT scan

North Anna Unit 1



North Anna Unit 1

North Anna Unit 1

Results

- No through wall indications
- Shallow indications do exist on tube ID which need to be monitored for growth rate (unknown if PWSCC)
- Visual inspection complicated by large amount of boric acid on the reactor vessel head from other sources
- NDE inspection complicated due to interferences (centering ring and anti-ejection ring)
- Inspections complicated by delivery equipment unreliability therefore equipment was partially redesigned and rebuilt between North Anna outages
- NRC representatives reviewed all NDE data on site
- Dose expended: 18 man-rem

Surry Unit 1

- 100% qualified visual performed
  - Less debris noted than North Anna 1
  - 27 of 65 penetrations initially rejected
  - 13 of 27 accepted when “debris” was easily removed by 40 psi compressed air (technique introduced by vendor, used elsewhere and verbally endorsed by NRR)
  - 4 of 27 accepted when “debris” removed by 60 psi air plus satisfactory UT
  - Leaving 10 penetrations from visual campaign as rejected visual

Surry Unit 1

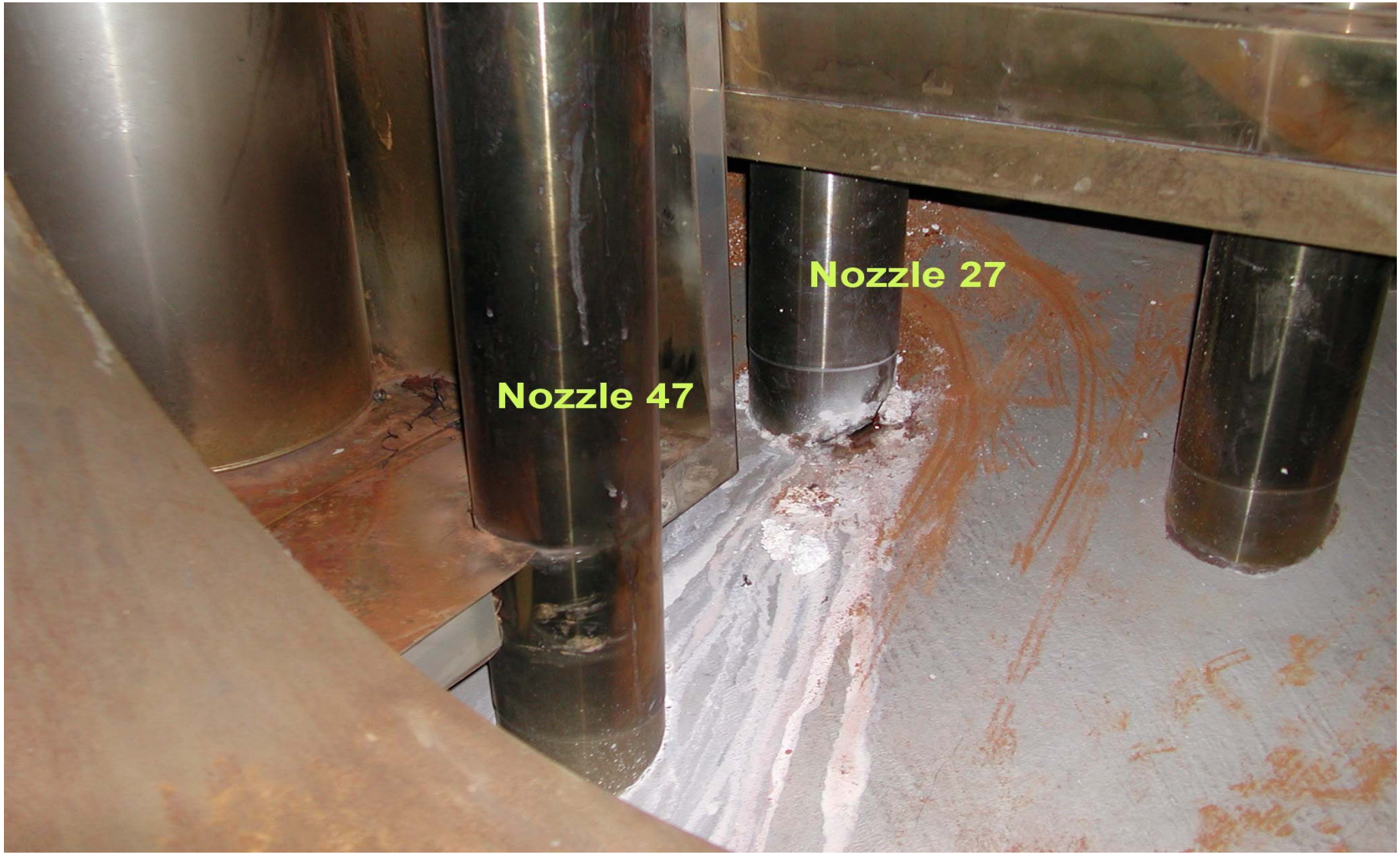
- NDE campaign
  - Axial UT probe used on 16 penetrations (including 6 cleared by air). No reportable indications
  - Circumferential UT probe used on 5 penetrations with LP indications in J-groove weld. No reportable indications
  - Vendor had no remote J-groove weld inspection capability
  - Manual liquid penetrant (LP) on 10 penetrations
  - 2 penetrations had circumferential LP indications in center of the weld, highly branched in appearance (penetration 27 had wet boron deposits on top)
  - 4 penetrations had rejectable indications that could not be ground out
  - 4 penetrations had indications that were ground out and accepted

Surry Unit 1

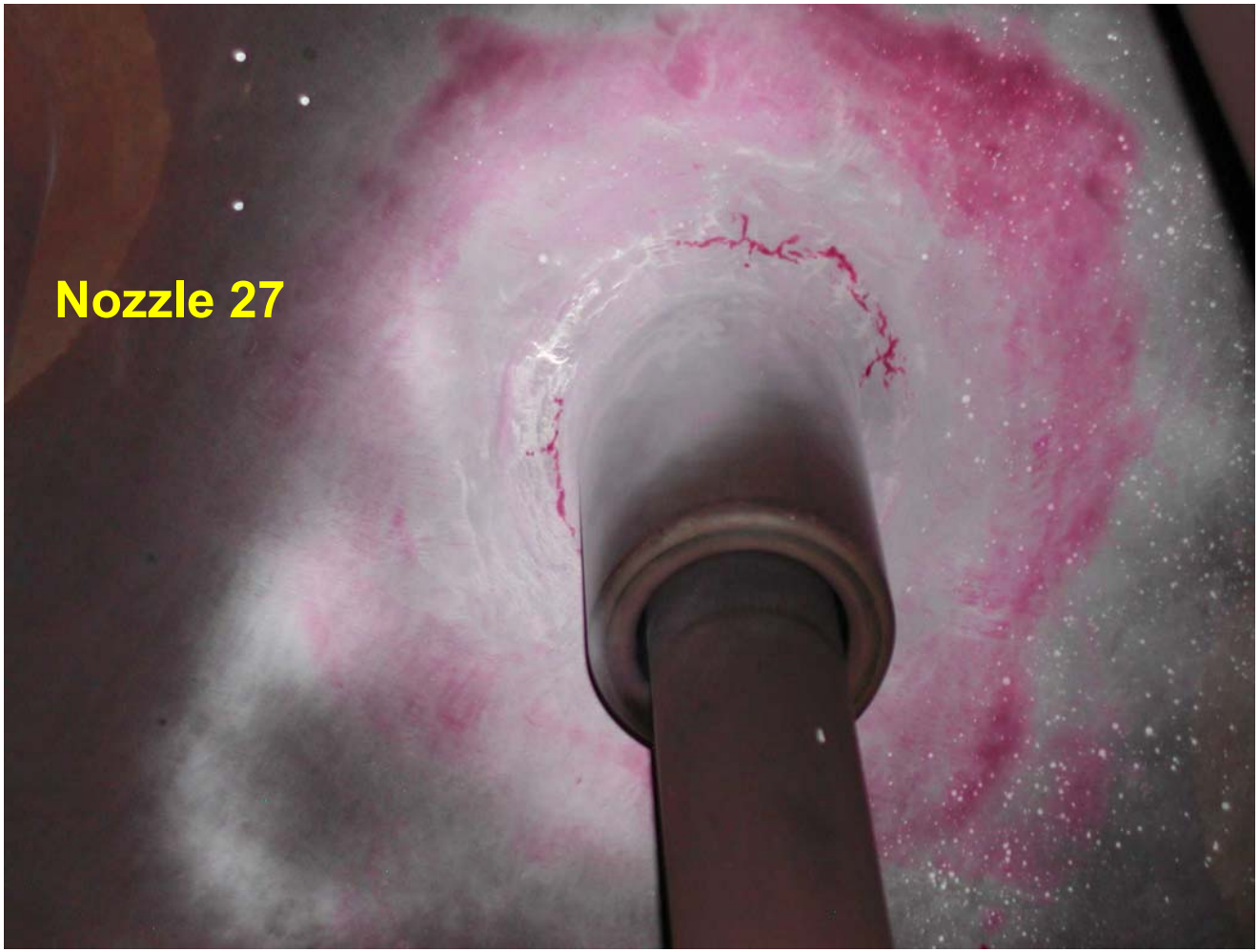
Results

- 6 penetrations were reported to the NRC as a non-emergency 8-hour report in accordance with 10 CFR 50.72(b)(3)(ii)(A) and 50.73(a)(2)(ii)(A), a condition that results in a principal safety barrier being seriously degraded
- All indications confined to weld, hasn't propagated to tube
- All 6 penetrations repaired
- Dose expended: 161 man-rem
- Templating performed for future head replacement

Surry Unit1



Surry Unit 1



Surry Unit 1

Surry Unit 1

North Anna Unit 2

- Performed 100% qualified visual inspection
  - Head extremely “clean”
  - 6 penetrations initially rejected
  - 3 of 6 cleared debris with air
  - 3 penetrations could not be cleared with air

North Anna Unit 2

- NDE campaign
  - Thermal sleeves removed on penetration 62, 63 to facilitate inspection (penetration 51 is T/C)
  - Performed EC in tube – indications on all tube IDs
  - Performed axial and circumferential UT – axial indications shallow and accepted by flaw evaluation
  - Bypassed EC in J-groove weld and went straight to LP examination. Indications in clad believed to be from original fabrication similar to Unit 1
  - Manual grinding and then remote grinding on penetration could not clear indication
  - Temperbead and embedded flaw relief requests approved as repair methodology for all 3 penetrations

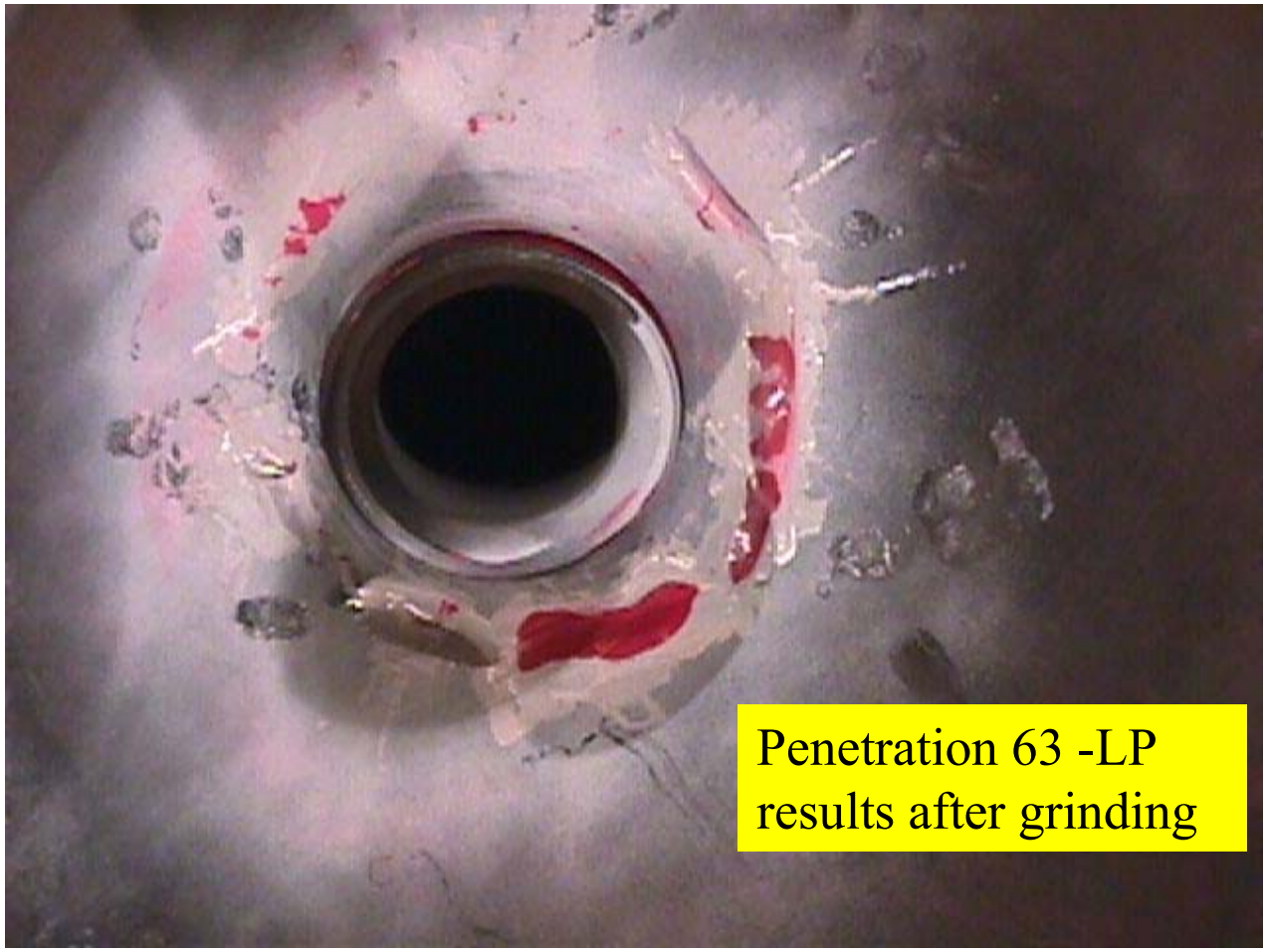
North Anna Unit 2

- NDE campaign (continued)
  - Boat sample removed from one penetration
    - Failure analysis revealed solidification or “hot” cracking confined to the Alloy 182, or butter, material.
    - A few of the hot cracks were connected to the wetted surface.
    - Some PWSCC noted which may have connected the hot cracking to the surface or may have occurred after the hot cracking connected to the surface
  - Ringhals Unit 2 found fabrication flaws between J-groove weld preparation and vessel in 1992. Identified after grind out of penetration 63
  - Dose expended: 69.947 man-rem

North Anna Unit 2

North Anna Unit 2

North Anna Unit 2



Surry Unit 2

- 100% qualified visual complete
- 3 penetrations masked and cleared with air
- No NDE inspection needed

Summary

- Reactor heads were cleaned and as-left condition documented
- Currently evaluating lessons learned
- Develop future strategies (inspection, repair, replacement)
- Push for better inspection technique in weld for flaw characterization
- Stay close to industry and regulator